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Optimizing an experimental design for an electromagnetic experiment

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Most of geophysical studies focus on data acquisition and analysis, but another aspect which is gaining importance is the discussion on acquisition of suitable datasets. This can be done through the design of an optimal experiment. An optimal experiment maximizes geophysical information while maintaining the cost of the experiment as low as possible. This requires a careful selection of recording parameters as source and receivers locations or range of periods needed to image the target.

We are developing a method to design an optimal experiment in the context of detecting and monitoring a CO_2 reservoir using controlled-source electromagnetic (CSEM) data. Using an algorithm for a simple one-dimensional (1D) situation, we look for the most suitable locations for source and receivers and optimum characteristics of the source to image the subsurface. One main advantage of this kind of technique to design an experiment is that it does not require the acquisition of any data and can thus be easily conducted before any geophysical survey.

Our algorithm is based on a genetic algorithm which has been proved to be an efficient technique to examine a wide range of possible surveys and select the one that gives superior resolution. Each configuration is associated to one value of the objective function that characterizes the quality of this particular design.

Here, we describe the method used to optimize an experimental design. Then, we validate this new technique and explore the different issues of experimental design by simulating a CSEM survey with a realistic 1D layered model.